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Final Report

MAY 1989

EVT 3-89

MIL-STD-1660 TEST OF  
PA117 WOOD UNITIZATION

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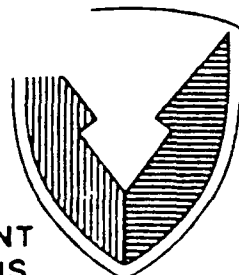


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EVALUATION DIVISION  
SAVANNA, ILLINOIS 61074-9639

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REPORT DOCUMENTATION PAGE				Form Approved OMB No. 0704-0188	
1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED			1b. RESTRICTIVE MARKINGS		
2a. SECURITY CLASSIFICATION AUTHORITY			3. DISTRIBUTION / AVAILABILITY OF REPORT		
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE			UNLIMITED		
4. PERFORMING ORGANIZATION REPORT NUMBER(S)  EVT 3-89			5. MONITORING ORGANIZATION REPORT NUMBER(S)		
6a. NAME OF PERFORMING ORGANIZATION U.S. Army Defense Ammunition Center and School		6b. OFFICE SYMBOL (If applicable) SMCAC-DEV	7a. NAME OF MONITORING ORGANIZATION		
6c. ADDRESS (City, State, and ZIP Code)  ATTN: SMCAC-DEV Savanna, IL 61074-9639			7b. ADDRESS (City, State, and ZIP Code)		
8a. NAME OF FUNDING / SPONSORING ORGANIZATION U.S. Army Armament Research, Development and Engineering Center		8b. OFFICE SYMBOL (If applicable) SMCAR-ESK	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER		
8c. ADDRESS (City, State, and ZIP Code)  ATTN: SMCAR-ESK Rock Island, IL 61299-7300			10. SOURCE OF FUNDING NUMBERS		
			PROGRAM ELEMENT NO	PROJECT NO	TASK NO
			WORK UNIT ACCESSION NO		
11. TITLE (Include Security Classification)  MIL-STD-1660 Test of PAl17 Wood Unitization					
12. PERSONAL AUTHOR(S) A.C. McIntosh, Jr.					
13a. TYPE OF REPORT FINAL		13b. TIME COVERED FROM _____ TO _____		14. DATE OF REPORT (Year, Month, Day) 1989 MAY	
15. PAGE COUNT 24					
16. SUPPLEMENTARY NOTATION					
17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)		
FIELD	GROUP	SUB-GROUP			
19. ABSTRACT (Continue on reverse if necessary and identify by block number)					
<p>The U.S. Army Defense Ammunition Center and School (USADACS), Evaluation Division, was requested by the U.S. Army Armament, Research, Development and Engineering Center (ARDEC), SMCAR-ESK, to test a PAl17 container unitization procedure. This unitization procedure used a MIL-P-15011 pallet. The tested configuration was five containers high, six containers wide, and did not have top lifting capabilities. The unit load satisfied the test requirements of MIL-STD-1660, Design Criteria for Ammunition Unit Loads; however, PAl17 container damage can be expected due to deformation of the square rings and container sidewall.</p>					
20. DISTRIBUTION / AVAILABILITY OF ABSTRACT <input checked="" type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT <input type="checkbox"/> DTIC USERS			21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED		
22a. NAME OF RESPONSIBLE INDIVIDUAL THOMAS J. MICHELS, CHIEF, EVALUATION DIVISION			22b. TELEPHONE (Include Area Code) 815-273-8080		22c. OFFICE SYMBOL SMCAC-DEV

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REPORT NO. EVT 3-89

MIL-STD-1660 TEST OF  
PA117 UNITIZATION

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## PART 1

### INTRODUCTION

- A. BACKGROUND. The U.S. Army Defense Ammunition Center and School (USADACS), Evaluation Division, was tasked by the U.S. Army Armament Research, Development and Engineering Center (ARDEC), SMCAR-ESK, to test unitization procedures for PA117 containers on wood pallets. The unit configuration was five containers high and six containers wide. No top lift assembly was used. The criteria used for evaluating the PA117 container wood pallet with top lifting adapter was MIL-STD-1660, Design Criteria for Ammunition Unit Loads.
- B. AUTHORITY. This test was conducted in accordance with mission responsibilities delegated by the U.S. Army Armament, Munitions and Chemical Command (AMCCOM), Rock Island, IL.
- C. OBJECTIVE. The objective of these tests was to determine if the PA117 container shipped in a six-wide by five-high unit without a top lifting adapter could satisfy the testing requirements of IL-STD-1660.

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PART 2

ATTENDEES

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### PART 3

#### TEST PROCEDURES

The test procedures outlined in this section are extracted from MIL-STD-1660, Design Criteria for Ammunition Unit Loads, 8 April 1977. This standard identifies nine steps that a unitized load must undergo if it is considered to be acceptable. These tests are synopsized below:

1. STACKING TESTS. The unit load shall be loaded to simulate a stack of identical unit loads stacked 16 feet high, for a period of one hour. This stacking load is simulated by subjecting the unit load to a compression of weight equal to an equivalent 16-foot stacking height. The compression load is calculated in the following manner. The unit load weight is divided by the unit load height in inches and multiplied by 192. The resulting number is the equivalent compressive load of a 16-foot high stack of unit loads.

2. LOOSE CARGO TRANSPORTATION TEST. The Loose Cargo Transportation test shall be conducted in accordance with Method 5019, Federal Standard 101. The test procedure is as follows: The test specimen shall be placed on, but not fastened to, the platform. With the specimen in one position, vibrate the platform at 1/2 inch amplitude (1 inch double amplitude) starting at a frequency of about 3 cycles-per-second. Steadily increase the frequency until the package leaves the platform. The resonant frequency is achieved when a 1/16-inch-thick feeler may be momentarily slid freely between every point on the specimen in contact with the platform at some instance during the cycle or a platform acceleration achieves one plus or minus zero point one G. Midway into the testing period the specimen shall be rotated 90 degrees and the test continued for the duration. If failure occurs, the total time of vibration shall be two hours if the specimen is tested in one position; and if tested in more than one position, the total time shall be three hours.

3. EDGEWISE ROTATIONAL DROP TEST. This test shall be conducted by using the procedures of Method 5008, Federal Standard 101. The procedure for the Edgewise Drop (Rotational) Test is as follows: The specimen shall be placed on its bottom with one end of the base of the container supported on a sill nominally 6 inches high. The height of the sill shall be increased, if necessary, to ensure that there will be no support for the base between the ends of the container when dropping takes place, but should not be high enough to cause the container to slide on the supports when the dropped end is raised for the drops. The unsupported end of the container shall then be raised and allowed to fall freely to the concrete, pavement, or similar underlying surface from a prescribed height. Unless otherwise specified, the height of drop for level A protection shall conform to the following tabulation.

GROSS WEIGHT NOT EXCEEDING	DIMENSIONS ON ANY EDGE NOT EXCEEDING	HEIGHT OF DROP LEVEL A PROTECTION
Pounds	Inches	Inches
600	72	36
3,000	no limit	24
no limit	no limit	12

4. IMPACT TEST. This test shall be conducted by using the procedure of Method 5023, Incline-Impact Test of Federal Standard 101. The procedure for the Incline-Impact Test is as follows: The specimen shall be placed on the carriage with the surface or edge which is to be impacted projecting at least 2 inches beyond the front end of the carriage. The carriage shall be brought to a predetermined position on the incline and released. If it is desired to concentrate the impact on any particular position on the container, a 4 by 4 inch timber may be attached to the bumper in the desired position before the test. No part of the timber shall be struck by the carriage. The position of



the container on the carriage and the sequence in which surfaces and edges are subjected to impacts may be at the option of the testing activity and will depend upon the objective of the tests. When the test is to determine satisfactory requirements for a container or pack and unless otherwise specified the specimen shall be subjected to one impact on each surface that has each dimension less than 9.5 feet. Unless otherwise specified, the velocity at time of impact shall be 7-feet per second.

5. DISASSEMBLY TEST. Following all rough handling tests, the unit load may be squared up within 2 inches of its original shape and on a flat level surface. The strapping shall then be cut and removed from the palletized load. Assembly of the load shall be such that it retains its unity upon removal of the strapping.

## PART 4

### TEST EQUIPMENT

#### 1. TEST SPECIMEN.

- a. Drawing Number:
- b. Width: 40 inches
- c. Length: 44 inches
- d. Height: 40 inches
- e. Weight: 1.838 pounds

#### 2. COMPRESSION TESTER.

- a. Manufacturer: Ormond Scientific
- b. Platform: 60 inches by 60 inches
- c. Compression Limit: 50,000 pounds
- d. Tension Limit: 50,000 pounds

#### 3. TRANSPORTATION SIMULATOR.

- a. Manufacturer: Gaynes Laboratory
- b. Capacity: 5,000 pound pallet
- c. 1/2-inch Amplitude
- d. Speed: 50 to 300 rpm
- e. Platform: 5 feet by 8 feet

#### 4. INCLINED RAMP.

- a. Manufacturer: Conbur Incline
- b. Impact Tester
- c. 10 Percent Incline
- d. 12-Foot Ramp

## PART 5

### TEST RESULTS

#### 1. COMPRESSION TEST

##### a. Pallet Data

1. Weight	1,838	pounds
2. Height	40	inches
3. Test Load	8,822	pounds

b. Applied test load duration                      60      minutes

c. Observations: The square bell ends deformed under a compression load of 9,000 pounds. The deformation was caused by the skids of the stacking pallet placed on top of the unit load to simulate a real stacking situation. The two outside and two inside square bells deformed under compression but did not take a set when the compression load was removed. The square rings at the center and rear of the PAll7 containers deformed and took a set after the compression load was removed.

#### 2. LOOSE CARGO TRANSPORTATION TEST

##### a. Longitudinal orientation.

1. Operating speed	200	rpm
2. Test Duration	90	minutes
3. Observations:	No visible damage.	

##### b. Lateral orientation.

1. Operating speed	200	rpm
2. Test Duration	90	minutes
3. Observations:	No visible damage.	

#### 3. EDGEWISE ROTATIONAL DROP TEST

##### a. Side 1

1. Drop Height	24	inches
2. Unit orientation	lateral	
3. Observations:	No visible damage.	

##### b. Side 2

1. Drop Height	24	inches
2. Drop orientation	longitudinal	
3. Observations:	No visible damage.	

##### c. Side 3

1. Drop Height	24	inches
2. Drop orientation	lateral	
3. Observations:	No visible damage.	

- d. Side 4
  - 1. Drop Height 24 inches
  - 2. Drop Orientation longitudinal
  - 3. Observations: No visible damage.

#### 4. INCLINED IMPACT

- a. Drop height for all impacts 7
- b. Side 1
  - 1. Orientation Lateral
  - 2. Observations: Flattened interlocks. Damaged square rings.
- c. Side 2
  - 1. Orientation Longitudinal
  - 2. Observations: No visible damage
- d. Side 3
  - 1. Orientation Lateral
  - 2. Observations: Flattened interlocks. Damaged square rings.
- e. Side 4
  - 1. Orientation Longitudinal
  - 2. Observations: No visible damage.

#### 5. DISASSEMBLY OBSERVATIONS

- a. All square rings of the base end of the PAll7 containers were permanently deformed.
- b. The outer containers in the top row exhibited a slight denting at the rear where the containers contacted the intermediate dunnage.
- c. Paint abrasion was observed on containers in contact with the intermediate dunnage.
- d. Containers on the bottom row, in contact with the pallet deck, sustained excessive denting that could prevent materiel removal.
- e. Damage to the bottom row of containers was greatest at the square ring end of the container and decreased toward the bell end.
- f. All square rings on the PAll7 containers showed some degree of deformation from the test sequence.

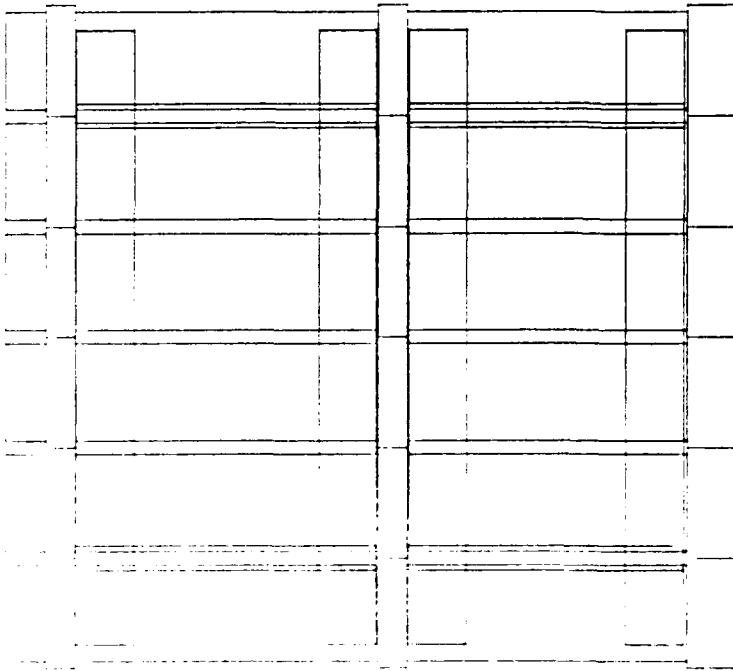
## PART 6

### CONCLUSIONS AND RECOMMENDATIONS

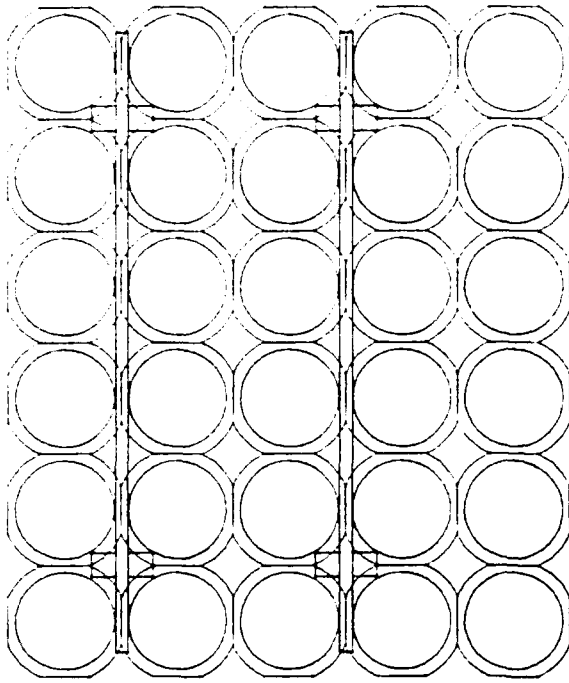
1. CONCLUSIONS. The unit configuration satisfactorily remained intact throughout testing. However, the unit does not protect the interlocks on the longitudinal sides when subjected to impacting. Examination of the pallet contents during the disassembly test showed paint abrasion on the containers and the bottom row of containers dented. Additional damage to the containers was caused due to the collapse of the square bell stacking rings as a result of the MIL-STD-1660 testing sequence. After disassembling, all square rings exhibited deformation propagating from the unsupported ring edge toward the supported edge. This procedure is adequate for physical transportation, but is marginal in terms of insuring undamaged containers and access to the rounds. The PA117 container square bells are not strong enough to withstand MIL-STD-1660 testing without deforming.
2. RECOMMENDATIONS. It is recommended that the PA117 container square bells, square rings, and cylindrical sections be strengthened to survive the MIL-STD-1660 test requirements and the expected logistics life cycle environment.

PART 7

UNITIZATION DRAWINGS

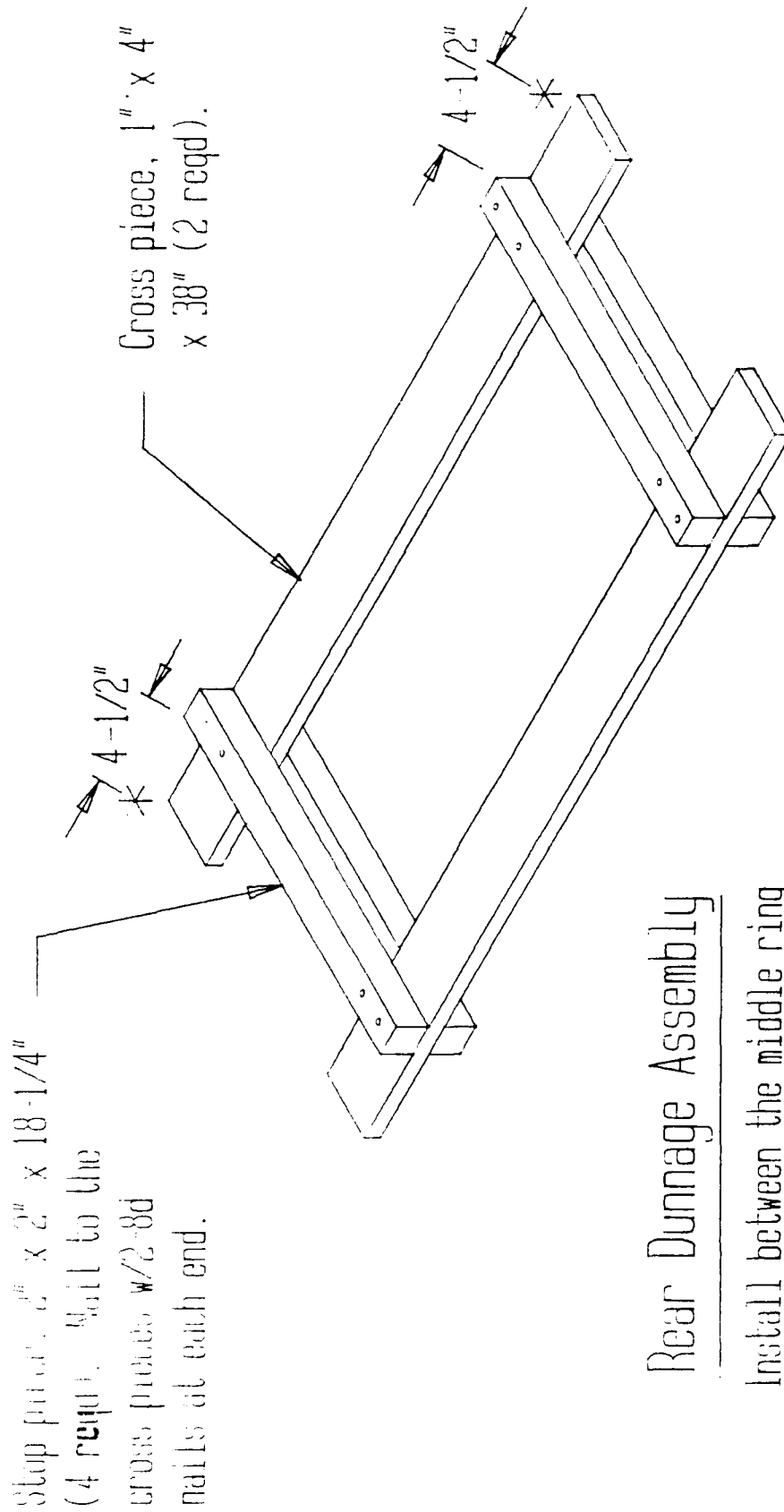


Top View



Side View

Placement of dunnage assemblies within the PA117 pallet unit (pallet omitted).



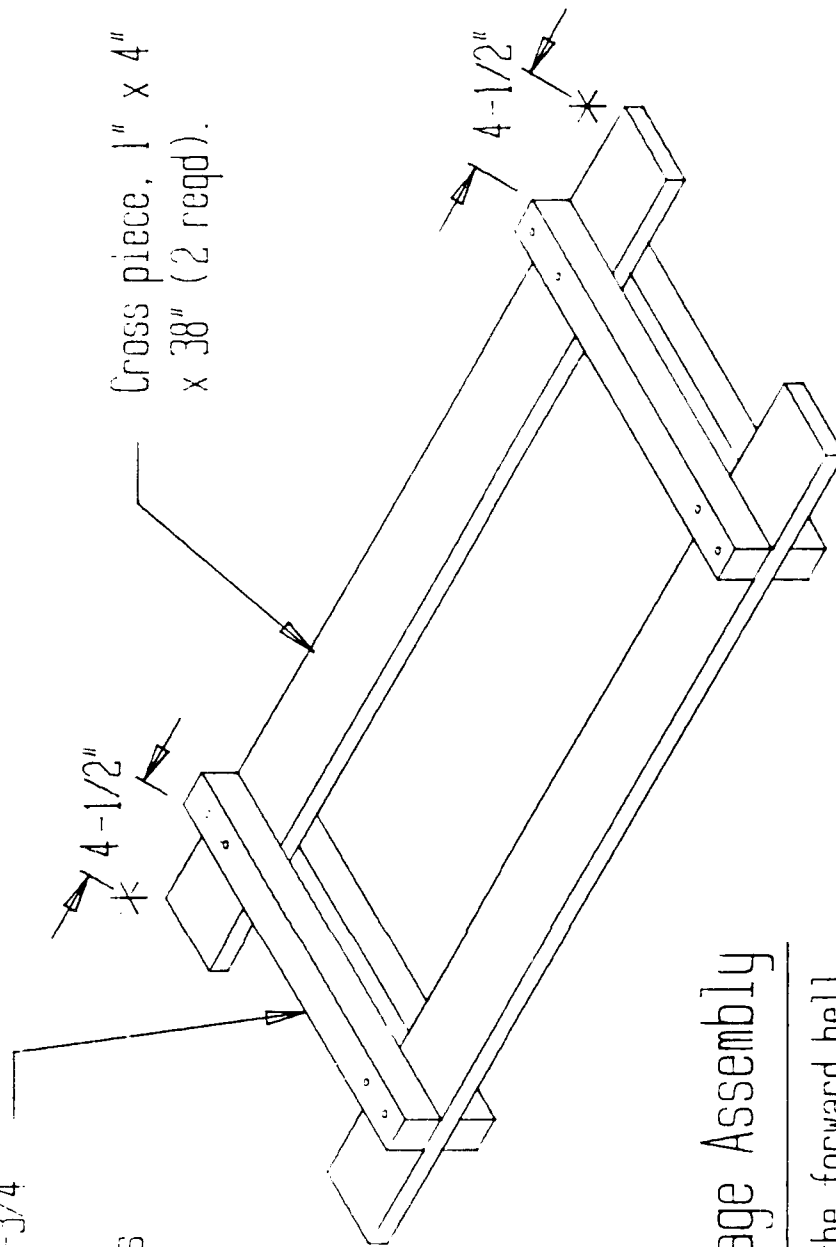
## Rear Dunnage Assembly

Install between the middle ring  
and the rear ring (2 reqd).



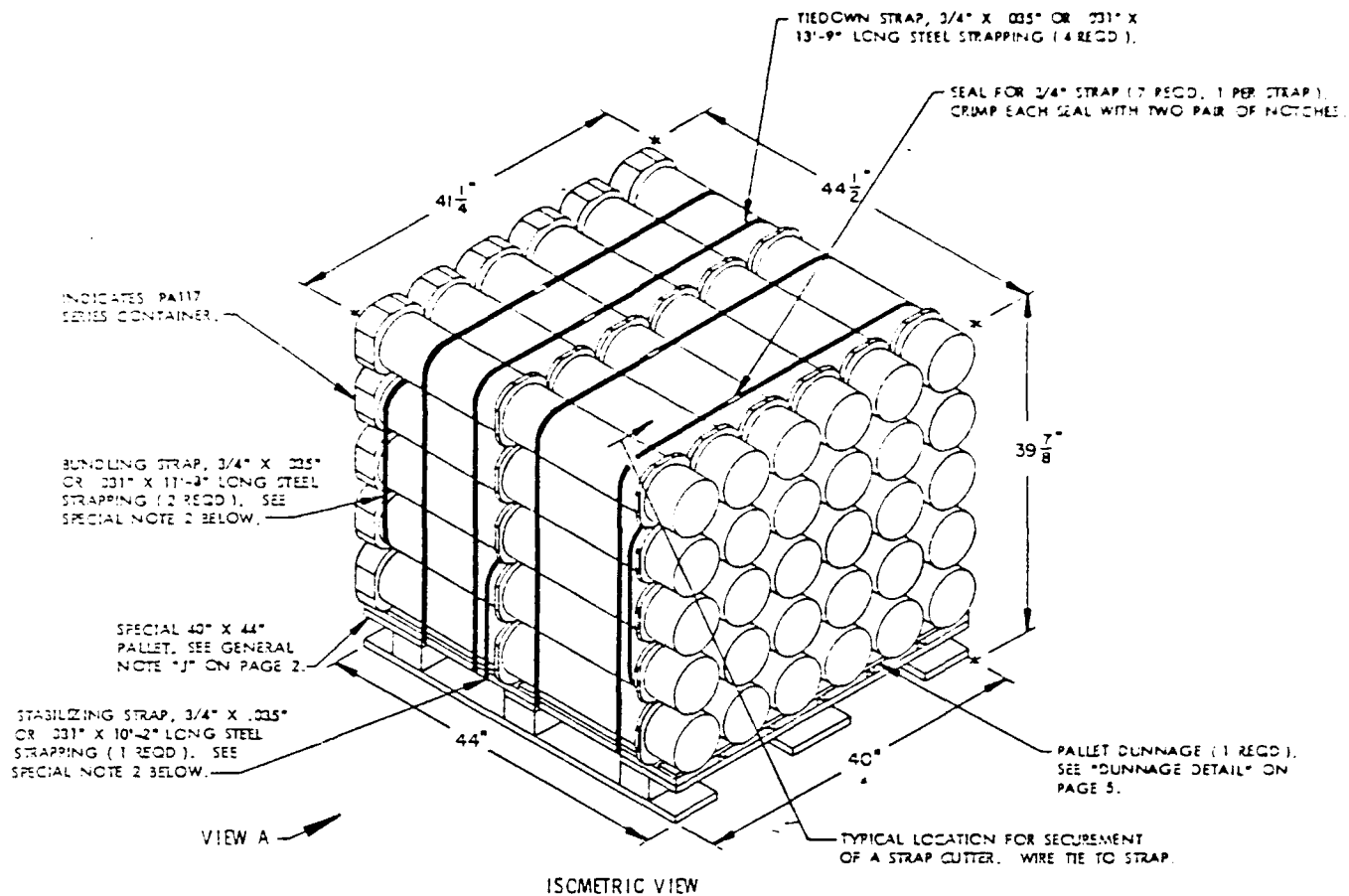
Stop piece, 2" x 2" x 16-3/4"  
(4 reqd). Nail to the  
cross pieces w/2-8d nails  
at each end.

Cross piece, 1" x 4"  
x 38" (2 reqd).



## Forward Dunnage Assembly

Install between the forward bell  
and the middle ring (2 reqd).

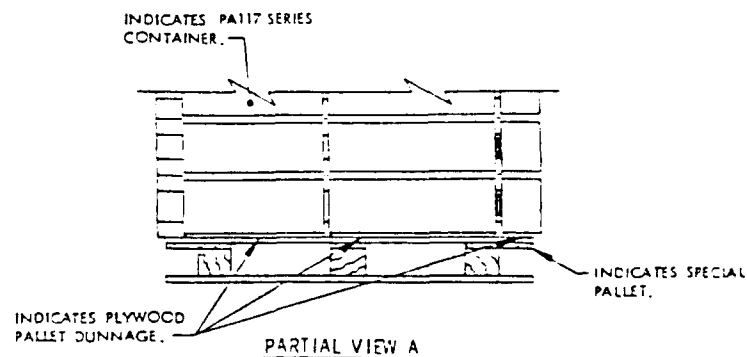


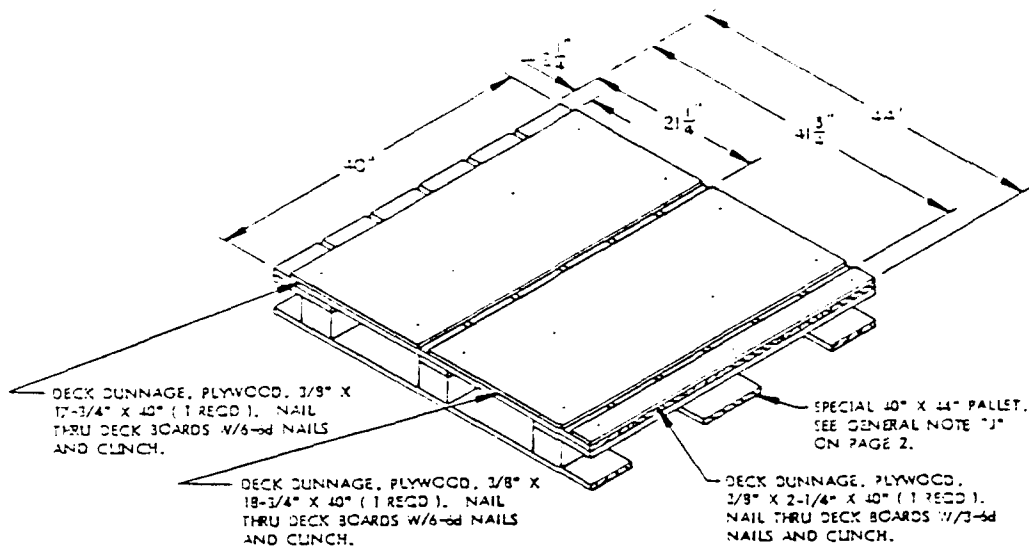
#### SPECIAL NOTES:

1. ALTHOUGH THE CONTAINERS DEPICTED IN THE UNIT LOAD ABOVE ARE CONSTRUCTED WITH INTERLOCKING DEVICES, THE INTERLOCKS WILL NOT FUNCTION PROPERLY UNLESS THE CONTAINERS ARE POSITIONED SO THAT THE "PINS" OF THE INTERLOCKS ARE IN AN UPRIGHT ORIENTATION. THIS ORIENTATION WILL PRECLUDE INTERFERENCE OF THE "PINS" AND THE PLYWOOD PALLET DUNNAGE. FOR THE LATERAL INTERLOCKS TO FUNCTION PROPERLY, THE LATERAL INTERLOCKING DEVICES ON THE RINGS OF A CONTAINER MUST BE ENGAGED WITH THE LATERAL INTERLOCKING DEVICES ON THE RINGS OF AN ADJACENT CONTAINER. LATERAL INTERLOCK ENGAGEMENT IS ACCOMPLISHED WHEN CONTAINERS ARE LOWERED ONTO THE PALLET UNIT. THE INTERLOCKS WILL AID IN THE PREVENTION OF CONTAINER MOVEMENT, BOTH LATERAL AND LONGITUDINAL, DURING SHIPMENT OF THE UNIT LOAD.

2. BUNDLING STRAPS AND STABILIZING STRAP MUST BE TENSIONED AND SEALED PRIOR TO THE APPLICATION OF THE TIEDOWN STRAPS.

3. ALL STRAPS MUST BE INSTALLED AS CLOSE AS POSSIBLE TO THE CONTAINER RINGS. CAUTION STRAPS MUST NOT BE ALLOWED TO OVERLAP.





PALLET DUNNAGE LOCATION

BILL OF MATERIAL		
NAILS	NO. REQD	POUNDS
6d (2")	15	0.39
SPECIAL PALLET, 40" X 44"	1 RECD	77 LBS
STEEL STRAPPING, 3/4"	52.57" RECD	6.26 LBS
SEAL FOR 3/4" STRAPPING	7 RECD	NIL
PLYWOOD, 3/8"	10.76 SQ FT RECD	11.10 LBS

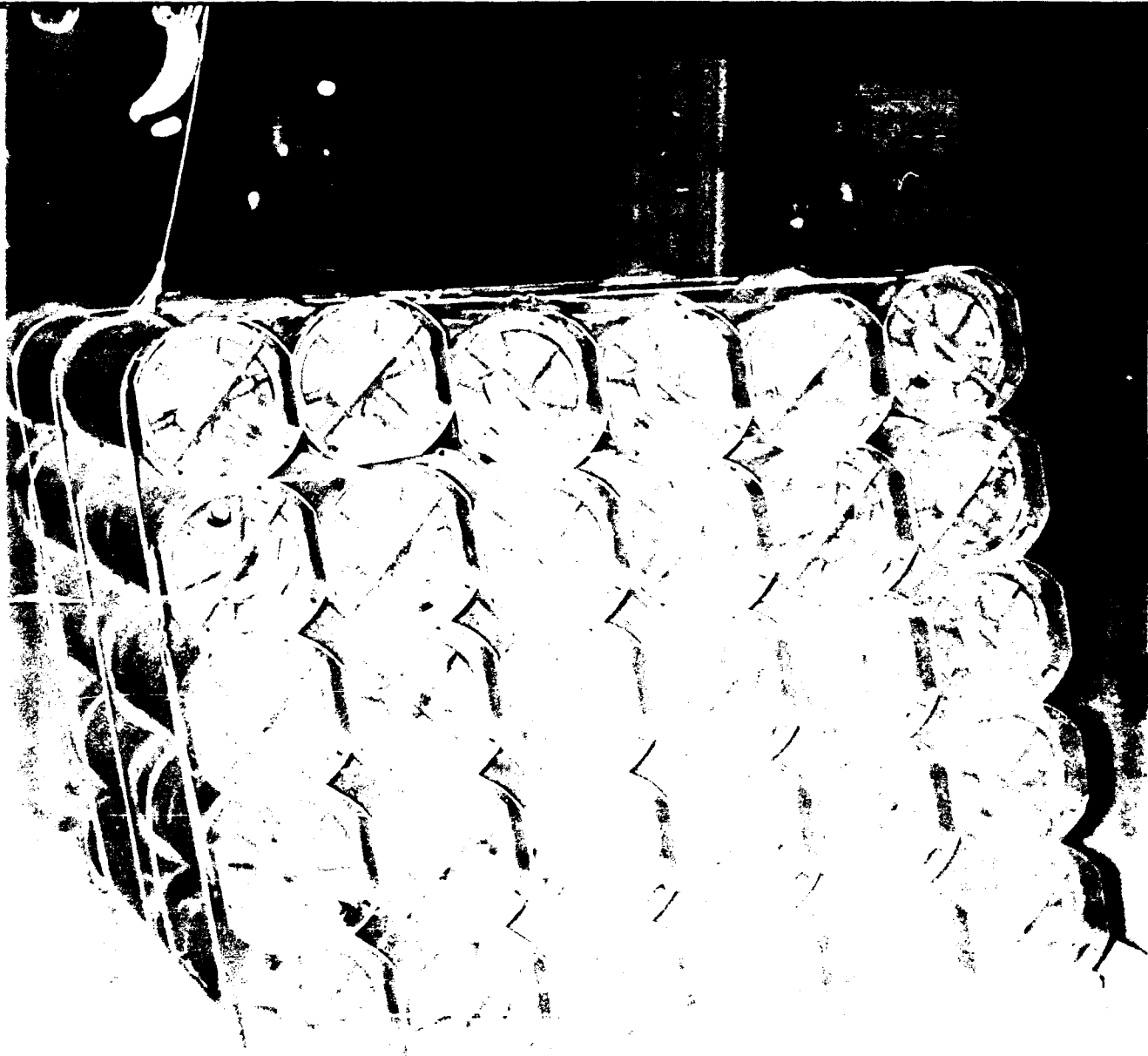
UNIT DATA

CUBE	41.8 CUBIC FEET ( APPROX )	
CONTAINER	30 EACH @ 57 LBS	1,710 LBS ( APPROX )
DUNNAGE		18 LBS
PALLET		77 LBS
TOTAL WEIGHT		1,805 LBS ( APPROX )

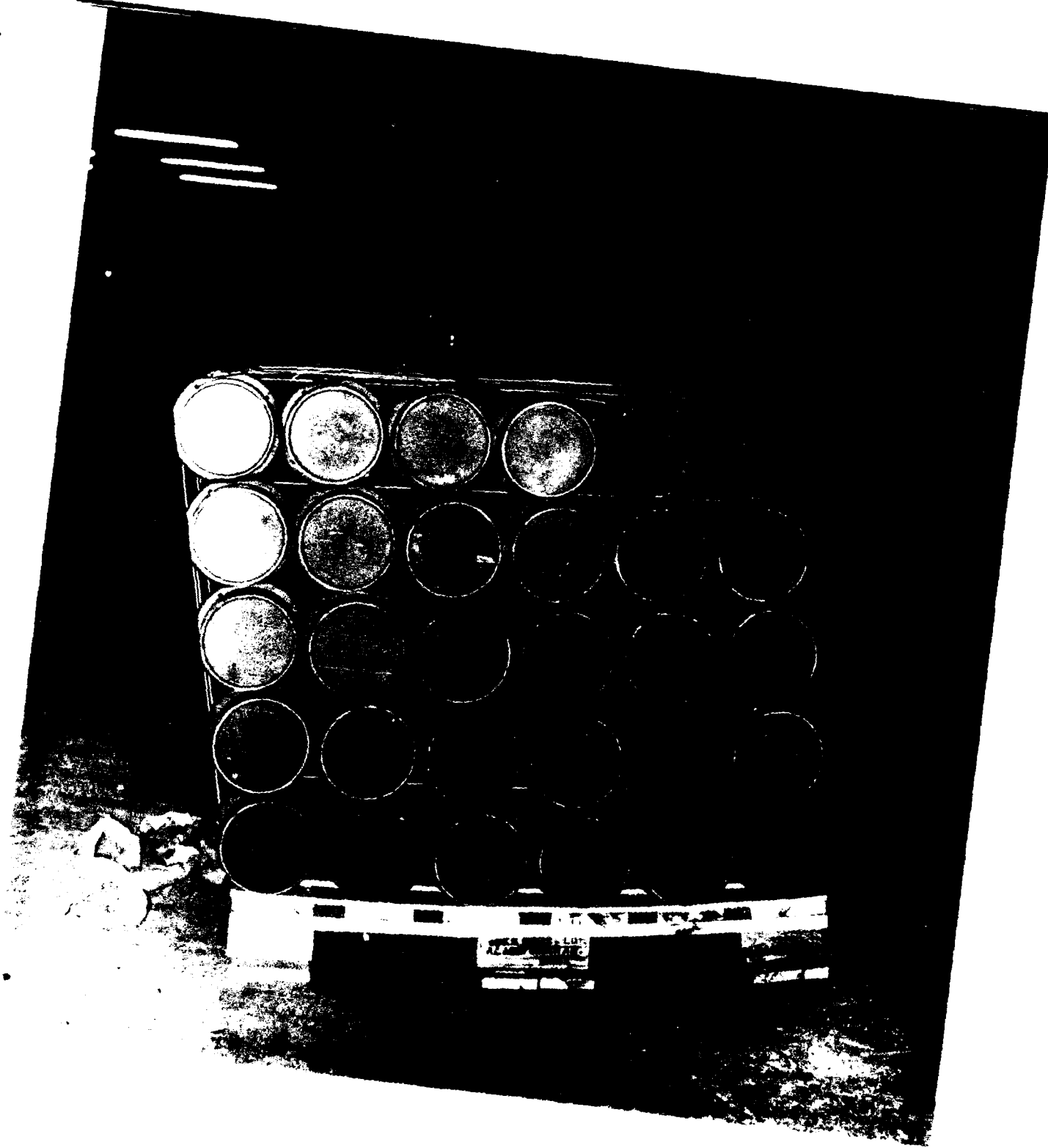
PART 8

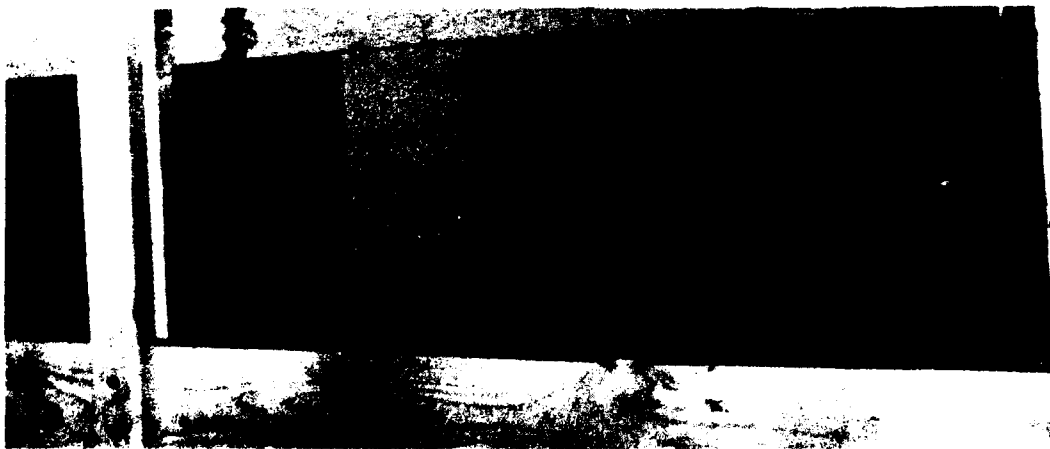
PHOTOGRAPHS

DEFENSE AMMUNITION CENTER AND COMPANY SAVANNAH, GA



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DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

Photo No. 3 (89-4229) This photo shows the intervening damage from the opposite side of the unit load. Notice the damage to the square bell on the PALL7 container between the first and second row from the row. This damage was caused by the MIL-STD-1660 testing on a wooden pallet. Note paint abrasion on the cylindrical portion of the container and deformation to the interior in the square ring.

DEFENSE AMMUNITION CENTER AND SCHOOL SAVANNA, IL

PHOTO NO. 4 (89-4232) This photo shows the pallet base of the pallet. The pallet base is in the center of the photo, showing where paint has rubbed off of the bottom of the containers. The bottom of the containers is damaged on the side and on the bottom.

